

December 3, 1895.

Sir W. H. FLOWER, K.C.B., LL.D., F.R.S., President,
in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the months of October and November 1895 :—

The total number of registered additions to the Society's Menagerie during the month of October was 112, of which 63 were by presentation, 24 by purchase, 1 by exchange, 2 were born in the Gardens, and 22 were received on deposit. The total number of departures during the same period, by death and removals, was 146.

The registered additions to the Society's Menagerie during the month of November were 80 in number. Of these 41 were acquired by presentation, 30 by purchase, 2 were born in the Gardens, and 7 were received on deposit. The total number of departures during the same period, by death and removals, was 83.

Amongst the additions, attention was called to the acquisition of a male specimen of the supposed new Wild Goat of the island of Giura, one of the Sporades, which had lately been described by Dr. Reichenow of Berlin (*Zool. Jahrb.* vol. iii. p. 598, 1888) as a distinct species, under the name *Capra dorcas*.

A communication was read from Dr. G. Stewardson Brady, F.R.S., containing a Supplementary Report on the Crustaceans of the group *Myodocopa* obtained during the 'Challenger' Expedition. To this were added notes on other new or imperfectly known species of the same group.

This paper will be published entire in the Society's 'Transactions.'

The following papers were read :—

1. On some Points in the Anatomy of *Pipa americana*. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society, Examiner in Zoology to the University of London.

[Received October 1, 1895.]

Through the kindness of Mr. Clarence Bartlett, I have been able to dissect two specimens of the Surinam Toad (*Pipa americana*) which had been forwarded to him in spirit from British Guiana. They proved to be in an excellent condition for dissection. So far as I am acquainted with the literature relating to this Amphibian,

there has been but one general account of the anatomy of the soft parts since the year 1825, when it was studied by Mayer¹, who did not, however, direct attention to the special matters upon which I desire to report in the present communication. Mayer dissected three individuals, and he remarked upon the fact that in all of them the alimentary canal for the greater part of the intestinal region was beset with numerous small spherical cysts, which were mistaken by his predecessor Fermin for glands appended to the alimentary tract, but which were recognized by Rudolphi as encysted Nematodes. There is no doubt about this identification, and I found them present in large numbers in both my specimens. It is remarkable to find a parasite so invariably and so numerously present in its host, though there are other similar instances, such as the Gregarines in the sperm-sacs of the common Earthworm. Mayer's paper deals not only with the abdominal viscera, but also with the skeletal and muscular systems. There is, however, an earlier paper² which is not without value; in the plates appended to this are illustrations of several of the viscera isolated from their surroundings. More recently Klinckowström and Grönberg³ have described and figured the structure of the skin, the larynx, the blood-vessels and the brain, besides some of the other viscera more or less incidentally.

The two main lobes of the liver⁴ are absolutely separated from each other, the entire chamber enclosed by the suspensory ligaments of the anterior abdominal veins intervening. Along one margin each of the two lobes is firmly attached to the suspensory ligament of the abdominal vein, to the "diaphragm" and to the lung. The left half of the liver is rather larger than the right, and is partly divided into two lobes. The globular gall-bladder is associated with the right half of the liver; it is partly covered over by it, and lies in close contact with the membrane supporting the anterior abdominal vein.

The anterior abdominal vein, instead of being firmly attached to the ventral parietes, is borne at the angle of a membrane which is V-shaped in transverse section. This membrane, however, in the hinder part of the body-cavity at any rate, seems to be merely the slightly displaced peritoneum, which in that region of the body is not closely adherent to the muscular parietes. On pulling the vein the whole of the peritoneum lining the body-cavity posteriorly readily came away. Anteriorly the state of affairs seems to be a little different. The abdominal vein is still supported by a V-shaped membrane, but the two folds of membrane are firmly attached to the parietes. So far my description applies to the female example of the frog dissected by me. In the male the abdominal vein appeared posteriorly to stand out freely from the body-wall. I

¹ "Beiträge zu einer anatomische Monographie der *Rana pipa*," Verh. k. Leop.-Car. Akad. 1825, p. 527.

² Breyer, 'Observationes Anatomicae circa fabricam *Ranae pipæ*' (Berl., 1811).

³ "Zur Anatomie der *Pipa americana*," Zool. Jahrb. Abth. f. Anat. 1894.

⁴ There is a small separate third lobe. See Zool. Jahrb. loc. cit. pl. 39, fig. 7.

could find no trace of any membrane until about halfway between the end of the abdominal cavity and the edge of the sternum.

At this point where the membrane began the vein bifurcates. In the female frog the bifurcation of the abdominal vein coincides with the commencement of the fixed attachment of the mesenteries already spoken of. In the anterior part of the abdominal region there is thus a tent-like cavity which might be mistaken—particularly in the male, where it ends abruptly posteriorly—for a pericardium. In this cavity lies the heart, with its closely adherent pericardium. The abdominal vein lies inside the “tent,” being here and there only loosely fastened to its walls. Where the abdominal vein bifurcates, which it does quite half an inch behind the edge of the liver, the cavity of the tent increases in depth vertically and its roof becomes attached to the stomach and commencing intestine, forming the ventral mesentery of the same.

This cavity is an exaggeration of a corresponding arrangement in the frog.

§ *The Diaphragm.*

I have already made use of the word “diaphragm” in describing the attachment of the liver. The liver is attached anteriorly on both sides of the body to a membranous wall which is continuous with the suspensory ligament of the abdominal veins and appears to limit the body-cavity anteriorly. To this is also attached the lung, and on the left side of the body in both sexes a deep pocket is formed behind the lung owing to the angle at which the two membranes join. This is slightly marked on the right side. Where the transverse vertical dissepiment is cut through it is seen not to mark the anterior boundary of the body-cavity. In front of it lie two cavities of considerable size, separated from each other by another vertical septum and from their fellows by the œsophagus. These cavities are suggestive of the water-tight compartments of a man-of-war. Whether they are true coelom or not I am unable to say.

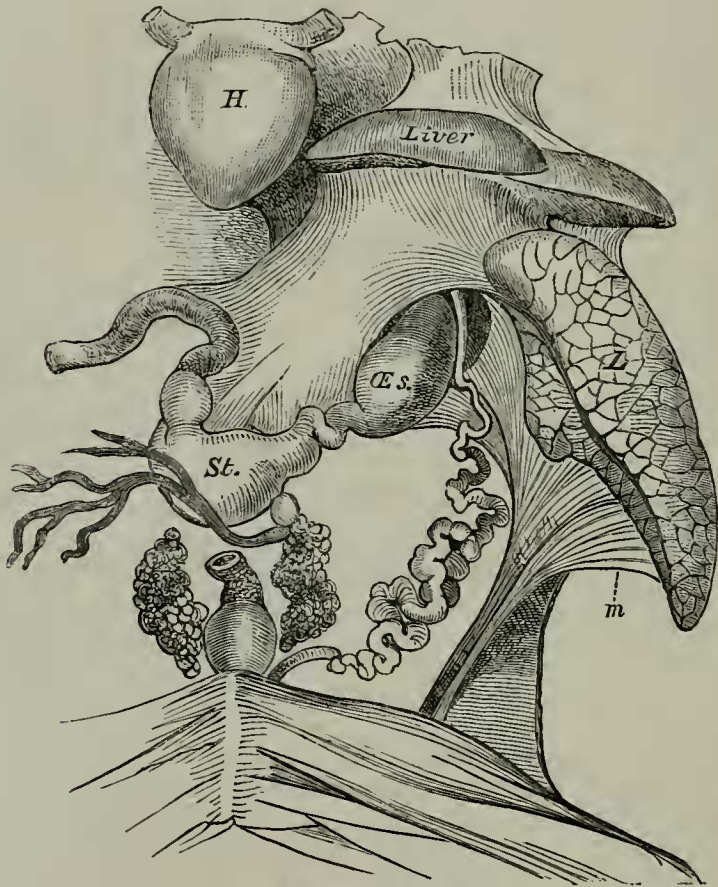
The septum to which the lung and the liver are attached is continuous with what I presume to be the dorsal peritoneum, or at least a portion of it. This membrane is tough and strong, and can readily be raised from the parietes. Anteriorly it is perforated by the two halves of the dorsal aorta, which lie perfectly freely in the space between the membrane and the parietes, being quite unattached to either. The anterior half of the cavity thus exposed by raising the tough peritoneal membrane is not floored (or rather roofed) by the muscles; these are covered by¹ a delicate semitransparent

¹ It is possibly comparable to what Mr. G. W. Butler has described (P. Z. S. 1889, p. 445) in the Bird. Development appears to show that the oblique septum in the Fowl is one structure with the aponeurosis covering the lungs, it having been blown away from it, to use Mr. Butler's phraseology, by the intermediate air-sacs. But septa remain connecting the two layers and separating the air-sacs. So, in *Pipa*, the peritoneum lying immediately behind the lung is separated by an interval from the peritoneum covering the muscles of the parietes, and anteriorly there is a vertical transverse septum joining them.

membrane in which run blood-vessels &c. From about the region where the two aortæ join, at the anterior end of the kidneys, there appeared to be no layer covering the muscles other than the first-described membrane.

The accompanying drawing (fig. 1) illustrates the lungs and the diaphragmatic membrane as seen from the interior of the body. It will be observed that the lung is bifid and that it is

Fig. 1.



Pipa surinamensis.

General view of abdominal viscera.

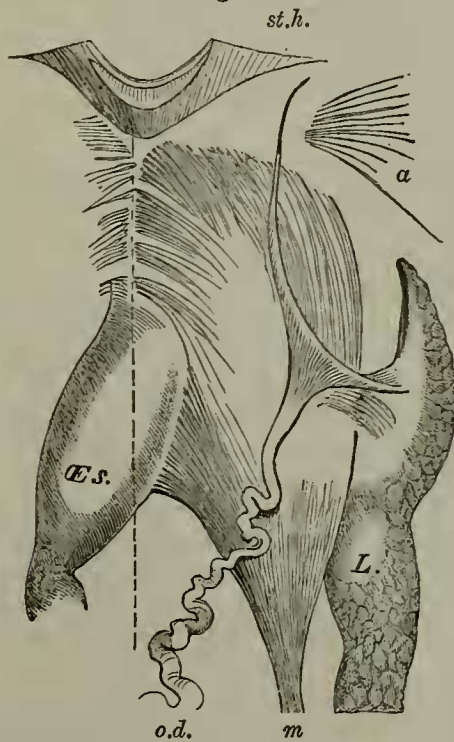
H., heart; *L.*, lung; *Es.*, œsophagus; *St.*, stomach; *m.*, musculus pulmonum proprius.

firmly attached to the membrane except in two regions; the smaller lobe is not so attached, and the main lobe is free for about the last three quarters of an inch of its length. The drawing will also partly explain why I have used the expression "diaphragm" in describing the strong sheet of peritoneum which is so readily detachable from the parietes. It will be noticed that narrow

muscle arises from the thigh close to the *rectus femoris*¹. This runs forward, increasing in breadth and undergoing a corresponding diminution in thickness; ultimately it fans out over the back of the lung and of the œsophagus; it begins to be attached to the lung first at the origin of the smaller lobe of that viscus. I cannot but think that the close attachment of the muscle to the lung must have some relation to the function of respiration.

The main mass of the muscles, however, go past the lung, and are, as already stated, inserted upon the œsophagus. At their insertion, which is on the median ventral side, they not only fan out, but the muscle becomes separated into a number of small separate bundles. The corresponding muscle of the opposite side of the body has to perforate the mesentery on its way to be inserted on to the œsophagus. All the fibres of the muscle are not, however, inserted in this way on to the œsophagus; a good number of them fan out

Fig. 2.



Pipa surinamensis.

Dissection to display diaphragm.

o.d., oviduct; *a*, branch of obliquus muscle; *st.h.*, sternohyoid.

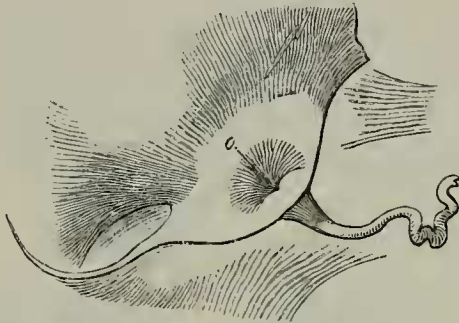
Other letters as in fig. 1.

dorsally and are inserted on to the aponeurosis already spoken of, which shuts off the abdominal cavity in front. The arrangement of these fibres is shown in the accompanying drawing (fig. 2).

¹ See p. 839.

In that drawing will be observed another muscle descending, in the position in which the animal is represented, from the ventral body-wall. This muscle is a portion of the sternohyoid, which leaves the anterior larger portion and is inserted just on to the posterior edge of the expanded hyoid cartilage and on to the aponeurosis, with which the hyoid cartilage is also in contact. A third muscular slip (fig. 2) from the obliquus also fans out over the diaphragm.

Fig. 3.

*Pipa surinamensis.*

Dissection to illustrate internal aperture of oviduct (o) borne upon a special membrane shown also in fig. 2.

I am not, however, directing attention for the first time to this curious structural peculiarity of *Pipa*. Breyer, in his memoir upon the anatomy of the frog, figures the lungs and the muscle attached to them, which he describes in the following words:—

“Tunicæ nimirum externæ [musculus] ab hepate oriundus additur, et musculorum adjacentium fibræ simul accedunt; sine pulmonis saltem dilaceratione, lacerti musculosi eidem affixi separari nequeunt.”¹

Physiologically, this fan-shaped muscle which spreads out over the back of the lungs in *Pipa* seems to be comparable to the muscles which arise from the ribs and spread out over the lungs in birds, and which Huxley regarded² as being collectively, and possibly, the homologue of the Mammalian diaphragm. Morphologically,

¹ Mayer gives a different account of the origin of this muscle. “Am merkwürdigsten von allen Muskeln ist aber der diesem Thiere eigenthümliche Lungenmuskel, *musc. pulmonum proprius*. Er entspringt, $1\frac{1}{2}$ Linien breit und $\frac{1}{2}$ Linie dick, von dem Darmbeinkamm unterhalb des *musc. latissimus dorsi*, geht nach auf- und einwärts, heftet sich an die hintere Fläche des untern Sackes der Lunge seiner Seite an, und verbreitet sich mit dicken strahlenförmig auseinanderfahrenden Fasern an dieser hinteren Wandung der Lunge.” But on a previous page he speaks of a separate muscle running to the pharynx. This *musculus abdominis posterior* “entspringt ebenfalls von dem Femur, aber an seinem äussern Winkel ist schmal, jedoch dick, tritt unter den *latissimus dorsi* in die Bauchhöhle hinein und erstreckt sich . . . nach aufwärts, indem seine Muskelfasern an der vordern und hinteren Fläche des Pharynx sich verbreiten.”

² “On the Respiratory Organs of *Apteryx*,” P. Z. S. 1882, p. 560.

comparisons are more difficult. Its insertion on to the stomach reminds us of Prof. Huxley's description¹ of a muscle in the Crocodile which "arises on each side from the anterior margin of the pubis; and its fibres pass forward, diverging as they go, to be inserted into the ventral face of the posterior part of the pericardium and into the ventral and lateral parts of the fibrous capsule of the stomach."

More important is the comparison with the frog, in which there is a muscle embracing the œsophagus, the so-called diaphragm. This is figured by Howes in the 'Atlas of Biology,' and described by Ecker as a part of the conjoined *obliquus internus transversus*; it arises, however, from the transverse process of the anterior vertebræ, but may still represent the anterior portion of the muscle described and figured here in *Pipa*. It is, however, perhaps more likely that the diaphragm of *Rana* is represented by the termination of the obliquus internus lettered *a* in my diagram (woodcut, fig. 2) of *Pipa*. If it be possible to compare the rudimentary diaphragm of *Rana* with that of the Mammalia, it seems even more possible in the case of *Pipa*. For in *Pipa* the diaphragm is formed by a dorsal and ventral set of muscles; there is a complete ring of muscles as in the Mammal.

The female frog which I dissected bore a number of young upon her back. I examined one of these, a fully-formed frog of about half an inch in length, in order to ascertain how far the various structures described above were visible. The anterior end of the young frog was cut into a series of longitudinal sections. I found that the lungs hung freely in the body-cavity after their emergence from the thoracic region; there was no trace whatsoever of any muscular or other attachment to the parietes. On the other hand, that section of the diaphragm which I have described above as shutting off the heart and pericardium from the abdominal cavity was present. So far, therefore, as one is at liberty to draw inferences from the order of development of various structures, the muscular fascia which spreads out over the lungs is a newer structure and perhaps conditioned by the special needs of *Pipa*, which is, as is well known, more purely aquatic in its habits than are many other Anurous Amphibia.

§ *Myology.*

The muscular anatomy of this Amphibian has been to some extent described by Mayer with an illustrative figure. I have endeavoured to supplement his account with some additional details. The animal was dissected side by side with an example of the large *Rana guppyi* from the Solomon Islands, which agrees in its myology with *Rana esculenta*, excepting in some small particulars noted in the course of the following description. The English translation by Haslam of Ecker's 'Anatomy of the Frog' has been my guide in comparing the muscles of the two animals,

¹ Ibid. p. 568.

which show a number of divergences other than those indicated by Mayer.

Muscles of the Head, Trunk, and Fore-limb.

The *obliquus externus* was, as Meckel has pointed out, overlooked by Mayer, who, however, curiously enough, figures it. It is only found in the posterior region of the abdomen, where it covers the pectoral and arises from the symphysis pubis and also from the rhomboidal area, mentioned in connection with the abdominal portion of the pectoral.

The *Rectus abdominis* is in three portions; one arises from nearly the entire length of the femur, and has been confounded by Mayer with the abdominal portion of the pectoral. As a matter of fact, it ends in a transverse band of tendon (a tendinous inscription), from which the pectoral arises. Another small portion runs from the symphysis pubis to the rhomboidal tendon already mentioned. The third portion is deep of the others, and passes forward on each side to the edge of the sternum.

The *obliquus internus* is a well-developed muscle which has an antero-posterior direction.

The *depressor mandibulæ* differs from that of *Rana* in that it arises from the skull itself and not from any fascia.

The *cucullaris* is an oblong muscle (it is triangular in *Rana guppyi*); at its insertion it overlaps the last muscle instead of being overlapped by it as in *Rana*.

The *latissimus dorsi* has a very remarkable arrangement, which differs greatly from that of *Rana guppyi*; in the latter it is a long triangular muscle which arises from the middle line of the back and runs nearly parallel with and over the hinder half of the *infraspinatus* to be inserted in common with it on the humerus. In *Pipa* the function of the *latissimus dorsi* is largely assumed by what I take to be the homologue of a portion at least of the *obliquus externus*. The latter is a fan-shaped muscle corresponding in shape and extent to the abdominal portion of the pectoral on the ventral side of the body. The muscle arises partly from the fascia covering the lateral abdominal region and partly from the great long transverse processes of the sacral vertebræ. It narrows to be inserted on to the humerus in common with the *infraspinatus* and partly on to lower border of scapula. Where it passes under the scapula it is joined by a delicate muscle consisting of a few widely separated fibres lying in the fascia covering the scapula. This I take to be the much-degenerated representative of the *latissimus dorsi* of *Rana*. It does not, however, blend with the fibres of the external oblique, but ends at right angles to them. It will be noticed, however, that the pull upon the forearm, which is the resultant of these two muscles, would not be widely different in direction from that exercised by the single *latissimus* of *Rana*. This, at any rate, might well be the case were the muscles equal in strength. I believe, however, that the decay of the *latissimus dorsi* bears some relation to the different movements

of the forearm required by so purely swimming a creature as *Pipa*, its place having been gradually taken by another muscle more fitted by its place of origin to bring about those movements.

A remarkable resemblance between *Pipa* and *Dactylethra* is afforded by the peculiar arrangement of the *latissimus dorsi* muscle in the two genera. Dr. Maurer¹ has described and figured in *Dactylethra* an "abdominal" portion of the *latissimus* which is quite as extensive as in *Pipa*. From the figure (fig. 10) which illustrates this I infer that the transversely running part of the muscle is also present. It is possible, of course, that the resemblance is one due to a similar environment, for *Dactylethra* is quite as aquatic in its habits as is *Pipa*. On the other hand, there is some evidence that the likeness is one indicating a deeper-lying affinity; for Maurer points out that in *Ceratophrys* the abdominal portion of the pectoral is feebly developed, while in *Dactylethra* it is large as in *Pipa*; in both of these genera the fore-limbs are largely used, and the fore-limb of *Ceratophrys* is much stouter than that of *Dactylethra*; so that on a *priori* grounds it might be expected that the pectoral of the former would be larger.

The same kind of argument might apply to the *latissimus*, which is the antithetical muscle to the pectoral. There are therefore some grounds for believing that the resemblance between *Pipa* and *Dactylethra* in this matter are resemblances of genetic importance. The great extent of this muscle in these two genera of Anurous Amphibians is suggestive of the Mammal to which it has been said that the myology of the Anura bears more resemblance than the Urodela.

The *rhomboideus* (or *retrahens scapulæ*), which in *Rana guppyi* arises almost entirely from the spines of the vertebræ—a small portion only springing posteriorly from the tendinous inscription of the *extensor dorsi communis*—and not from the transverse processes as in *Rana esculenta*, is totally absent in *Pipa*. To the under surface of the scapula are attached three muscles, which Ecker terms the *transversi scapulares*; they are all three present in *Pipa*.

So, too, are the *levator anguli scapulæ*, the *sternocleido-mastoid*, and the *protrahens scapulæ*, which attach the scapula to the head.

The *infraspinatus* arises, as in the frog, from a large portion of the dorsal surface of the scapula; a few fibres, however, take their origin from the fascia which lies between the scapula and the head. In the frog a straight line ruled across the scapula would indicate the sharply marked anterior boundary of the origin of the muscle. In *Pipa* the corresponding line is V-shaped, the muscle being really in two parts. The anterior half of the muscle, which extends further beyond the edge of the scapula than in *Rana*, crosses over the posterior portion near to the insertion and narrows rapidly to a thin tendon which is inserted in a line with, but inde-

¹ "Die ventrale Rumpfmuskulatur der anuren Amphibien," Morph. Jahrb. 1895.

pendently of and anterior to¹ the insertion of the lateral half of the muscle. The posterior half of the muscle is the larger; it ends in a flat, widish tendon, which is joined behind by the tendon of the *latissimus dorsi*. Neither part of the muscle has any relation to the deltoid, such as is the case with *Rana guppyi*; in that frog the tendon becomes adherent to the tendinous sheath of the deltoid before its own insertion.

There is a small *submental*is.

The *submaxillaris* (*mylohyoid*) is divided into two portions, as it is in the Common Frog. The anterior, much the larger, portion runs across the floor of the mouth in the usual way, while the small posterior portion arises from the hyoid. The main part of the muscle arises by six separate digitations from the mandibular margin, as described by Mayer, who gave it on this account the title of "*musculus hexagastricus*."

Pectoro-mandibular. Beneath the last-mentioned muscle is a sheet of muscular fibres which is totally unrepresented in the Common Frog and which has a very peculiar distribution. The muscle appears to correspond to Mayer's "*pectoralis superior*," but is not fully described or figured by him. The muscle is inserted along the entire length of the mandibles. It arises from the fascia covering over the sternal region of the pectoral muscles, and completely covers those muscles itself. At one corner it is inserted on to the humerus in common with the pectorals. They may possibly correspond to the *cutaneus pectoris* of the frog and to the *panniculus carnosus* of mammals.

The *sternoradialis* is very much larger in proportion in *Pipa* than it is in *Rana*. It is at least four times as large as either of the sternal portions of the pectoral, and is indistinctly divisible into three masses. Its tendon, passing to forearm, does not run between the divisions of *pectoralis* as in *Rana*.

The *pectoralis* consists of three parts, or, if we include the *pectoro-mandibular* described above, four separate portions. (1) The abdominal portion is of considerable extent, and the two muscles are separated anteriorly by a fascia continuous with them, which ends anteriorly in a free edge lying on the sternum. Posteriorly the fibres originate from a rhomboidal plate of tendon figured by Mayer, which lies medianly and posteriorly from tendinous intersection with *rectus abdominis*. (2) The anterior sternal portion is superficial to the *sternoradialis*; it arises by a thin flat tendon from the middle line of the sternum. (3) The posterior sternal portion is in contact with the *sternoradialis* for its whole length.

The *coraco-humeralis* is well developed.

The *deltoid* of *Rana guppyi* does not correspond with Ecker's description of that muscle in *Rana esculenta*. The scapular and clavicular heads are the same, but there is, in addition, a third head which ought perhaps to be regarded as a distinct muscle.

¹ *i. e.* nearest to the hand.

It is triangular in form and arises from the clavicle up to about halfway up, and from the base of the scapula anterior to the attachment of the clavicle. The fibres converge to an insertion upon the humerus nearer to the shoulder-blade than that of the *deltoid*. In *Pipa* the smaller head of the *deltoid* only arises from the clavicle and does not reach the omosternum; it may therefore rather correspond to the muscle just described in *R. guppyi* than to the clavicular head of the *deltoid* of that frog and of *Rana esculenta*.

Pectoralis minor. This muscle, to which I provisionally give the above name, is another muscle which is apparently absent from the shoulder of *Rana esculenta*, as I can find no description of it in Ecker. But it is present in *Rana guppyi*. It arises from the coracoid, but from the lower part, not from the upper part where the *coraco-humeralis* takes origin. It is, indeed, rather related to the *subscapularis* running parallel with that muscle, and indeed partly covered by it for nearly the whole of its course, but everywhere separable from it. It is a fleshy muscle with fleshy origin and insertion. At the insertion it bifurcates and is attached to the humerus on either side of the tendon of insertion of the posterior sternal portion of the *pectoralis*.

I find this muscle in *Pipa*, where, however, it is quite insignificant compared with the large muscle of *Rana guppyi*; it arises from the lower portion of the coracoid, and is hardly distinguishable either at its origin or insertion from the *coraco-humeralis*, except that it is entirely fleshy, while the *coraco-humeralis* is inserted by a strong tendon.

Muscles of the Leg.

When the muscles of the thigh are exposed to view by removing the skin, five muscles are visible on the ventral surface in *Rana*. *R. guppyi* is precisely like *R. temporaria*. These muscles are, commencing with the anterior border of the thigh, *vastus internus*, *sartorius*, *adductor magnus*, *rectus internus major*, and *r. i. minor*. In a similar preparation of the corresponding region of *Pipa* it is necessary, in order fully to display the muscles, to cut away the origin of the *rectus abdominis*; for this muscle in *Pipa* arises from nearly the entire length of the femur, and naturally, therefore, entirely hides the *vastus internus*. When this dissection is effected no less than seven muscles are visible, six of them for nearly the whole of their course, as shown in the accompanying drawing (fig. 4).

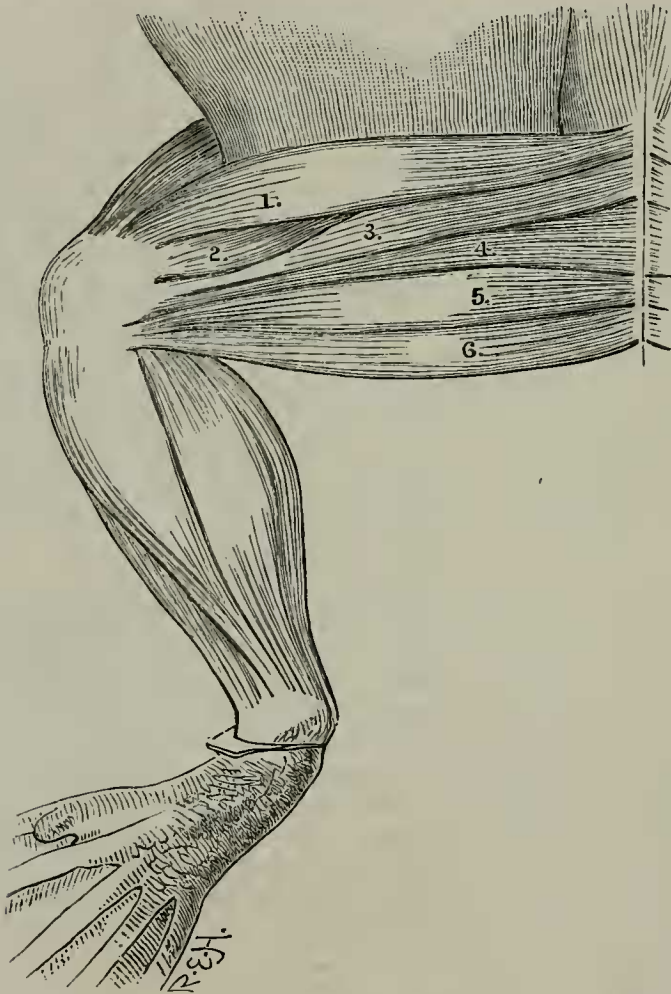
But a very important muscle of the thigh of *Rana* is totally wanting in *Pipa*—that is, the *sartorius*; I could find no trace of this muscle¹, the absence of which is possibly to be accounted for by the physical impossibilities introduced by the attachment to the femur of the abdominal musculature.

The *adductor magnus* is more completely divisible into two parts than it is in *Rana*. In *Rana* the muscle is, as it were, split,

¹ Mayer calls "*sartorius*," what I term *semitendinosus* (anterior head). . .

near to the origin, for the emergence of the anterior half of the double-headed *semitendinosus*. In *Pipa* the *adductor* in question arises by two distinctly separate heads of origin; the two bellies do not unite even at their attachment, where, however, they are naturally contiguous, though not in any way fused to form a common insertion. The anterior part of the muscle arises by a flat tendon

Fig. 4.

Thigh-muscles of *Pipa*.

- 1, adductor magnus; 2, semimembranosus; 3, 4, semitendinosus;
5, 6, recti interni.

of considerable length; the second part of the muscle lies below and behind the first; it has a completely fleshy origin; it is chiefly hidden on a superficial view by the anterior part of the *semitendinosus*. The first part of the muscle is attached only to the

inner and under surface of the extremity of the femur ; the second half has a more extensive insertion on to about the last half of the femur.

The *adductor longus* is perfectly distinct from the foregoing, Its attachment is to the proximal part of the femur, and ends not long after the commencement of the attachment of the *adductor magnus*.

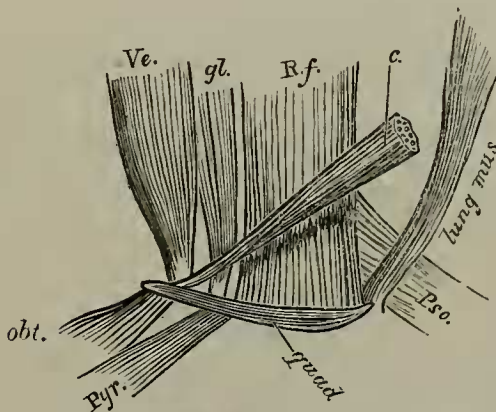
The *adductor brevis* has an attachment to the femur, which is not so long as that of the last-described muscle.

The *semitendinosus* has two distinct heads, which, however, lie side by side, and are quite superficial in origin. They become fused about two-thirds of the way between the origin and insertion ; a little after this they dip under the *recti interni*, and are inserted on to the fascia of the knee by a strong narrow tendon.

The two *recti interni* are subequal in size.

The *rectus femoris* group consists, as in the frog, of three muscles ; but the middle muscle of the "triceps," the *rectus anticus femoris*, differs entirely from that of *Rana*. It is a thin and broad sheet of muscle, which arises entirely from the wide plate of bone which is formed by the transverse process of the sacral vertebra, and passes straight downwards parallel with the *glutæus* to be inserted directly on to the proximal portion of the femur ; it does not fuse with either of the *vasti*, which are both present and normal. At its insertion (see fig. 5) it is in contact with the long muscle already described as running to the lung.

[Fig. 5.



Some of the thigh-muscles of *Pipa*.

Ve., vastus externus ; *gl.*, glutæus ; *R.f.*, rectus femoris ; *quad.*, quadratus ; *Pso.*, psaos ; *c.*, biceps ; *lung mus.*, musculus pulmonum proprius ; *Pyr.*, pyriformis ; *obt.*, obturator.

The *biceps* is a slender muscle arising just below the *vastus externus* ; it ends by a long thin tendon upon the head of the tibia.

The *quadratus femoris* is a small slender muscle, covered by the *biceps*, exactly beneath which it lies.

The accompanying drawing (fig. 5) of the muscles visible in a dissection of the outer side of the thigh shows two which I identify with the *pyriformis* and *obdurator* respectively.

The *semimembranosus* is a very stout muscle.

The *psoas* is also well developed.

I could not find a *pectineus*, unless what I have called the *adductor brevis* be really that muscle? But I do not think, after a comparison with *Rana guppyi*, that I have made this mistake. The *gastrocnemius* is a very stout muscle, which arises by a short strong tendon from the femur only. At the ankle it passes into the strong sesamoid bone, well known in the Common Frog; perfectly continuous with the latter is a flat strap-shaped tendon, which immediately divides into two divergent tendons, which go to be inserted upon two cartilages which are attached below the heads of the first and fifth metatarsals respectively. The two tendons are united for their whole length by a thin tough fascia. The two tendons and the uniting fascia apparently correspond to the plantar fascia of the frog. But in *Rana guppyi*, at any rate, the fascia is evenly stout throughout, and does not strip off in the same way because muscles are attached to it.

The *tibialis posticus* does not differ in essentials from Ecker's account of that muscle in the Common Frog; but neither in *Pipa* nor in *Rana guppyi* does the origin of the muscle extend along the whole length of the tibia; there is a considerable area at the upper end free from it.

The *tibialis anticus* also needs no comment, save that the division into two bellies is higher up the leg than in *Rana guppyi*.

The *peroneus* is well developed.

So also is the *extensor cruris*; both these muscles are much as in *Rana*.

The *flexor tarsi anterior* consists in *Pipa* of a stoutish muscle, which arises from about the middle of the tibia.

The *flexor tarsi posterior* has no extensor of the middle toe attached to it as in *Rana*.

§ Summary of the principal Differences in the Musculature of *Pipa* and *Rana*.

The following muscles, which are present in *Pipa*, are wanting in *Rana*:—(1) *Pectoro-mandibular*. (2) Abdominal portion of *latissimus dorsi*. (3) *Pulmono-oesophageal*.

The following muscles, which are present in *Rana*, are wanting in *Pipa*:—(1) *Rhomboideus*. (2) *Omohyoid*. (3) *Pectoro-cutaneus*. (4) *Sartorius*. (5) *Pectineus*. (6) Branch of posterior *extensor tarsi* to third toe.

Other points of difference are:—

(1) Origin of *depressor mandibular* from skull-wall in *Pipa* instead of from fascia covering neck. (2) Small size of clavicular

portion of *deltoid* in *Pipa*. (3) Double nature of *infraspinatus* in *Pipa*. (4) Separate attachment of middle portion of *triceps femoris* to thigh in *Pipa*. (5) Origin of abdominal muscles from thigh in *Pipa*, instead from pubis as in *Rana*.

In addition, a number of smaller differences will be apparent from a consideration of the foregoing account of the myology of *Pipa surinamensis*.

2. On the Diaphragm and on the Muscular Anatomy of *Xenopus*, with Remarks on its Affinities. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society, Examiner in Zoology to the University of London.

[Received October 31, 1895.]

Having dissected and described¹—I believe with greater detail than had been done previously—the “diaphragm,” as well as the muscular anatomy generally, of the Surinam Toad (*Pipa*), I was anxious to see how far there was a resemblance with the African genus *Xenopus* (*Dactylethra*); for in spite of their wide separation in space and divergent external characteristics, many naturalists hold that these two genera are closely related, to which opinion expression has been given by placing them in one division of the Anura—the Aglossa. The opportunity of making the requisite dissections has been afforded by the death of a female specimen, presented to the Society a year or two since by Mr. F. Finn, F.Z.S., which was brought to me directly after death, and was therefore in good condition.

§ *The Diaphragm.*

Before proceeding to record the presence of various bands of muscle which I believe correspond to the complicated diaphragm of *Pipa*, I shall direct attention to certain of the viscera in the neighbourhood. The lung itself is in some respects intermediate between that of *Rana* and that of *Pipa*, as regards its fixation to the body-wall. In *Rana* the lungs lie entirely free in the cœlom with the exception of their roots. In *Pipa*, on the other hand, a considerable length of the lung is firmly attached to the body-wall. *Xenopus* stands midway between these two extremes; a fold of peritoneum of about half an inch in length ties the lung to the body-wall. There is also a pulmono-gastric attachment. Beneath the lung is a deepish pocket whose right and left walls are formed by these two mesenteries; within this lies the terminal section and internal orifice of the oviduct. This aperture, it will be noticed from the figure (fig. 2), lies to the inner side of the lung; in *Pipa* the aperture of the oviduct lies quite to the side (inner) of the lung, and is borne upon a special fold of peritoneum, which I have illustrated in my account of the anatomy of that batrachian. In *Rana*, on the other hand, the oviduct crosses

¹ “On some Points in the Anatomy of *Pipa americana*,” above, p. 827.

the base of lung behind it and then curves back on the anterior face of the lung, where it opens. The various membranes which in *Xenopus* connect together the lung with the oviduct, and the lung with the stomach, and each of them with the parietes, form a closed sac lying beneath the stomach. The proximal section of the oviduct lies on the outer wall of this sac. As in *Pipa*, the heart and pericardium are enclosed in a membranous sac.

We now come to the diaphragm, by which I understand the muscles which are particularly related to the lung and œsophagus.

Fig. 1.



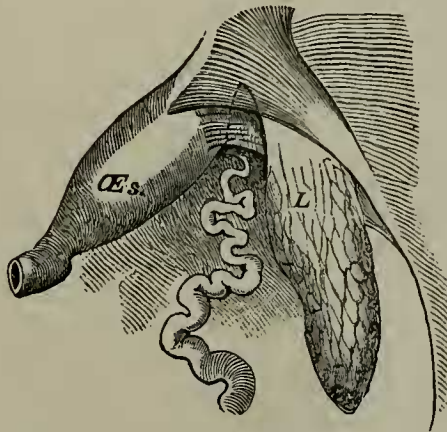
Interior of abdominal cavity of *Xenopus*.

L, lung; *m.p.*, musculus pulmonum proprius; *a*, branch of obliquus internus; *gl*, gluteus.

The muscular fibres are, as in *Pipa*, derived from three sources :—
 (1) There is first of all a special muscle whose main concern is with the lungs and œsophagus. This is, I believe, not merely the analogue, but the homologue of the "*musculus pulmonum proprius*," as Mayer termed the muscle which I have illustrated in figs. 1 and

2 of my paper upon *Pipa*¹. But it has a different origin. The accompanying drawing (fig. 1) illustrates the muscle in question with various adjacent structures. *gl.* is a large muscle which I describe later as the "*glutæus*," though it may represent the *glutæus* and a *psoas magnus*—the "*psoas*" of my subsequent description (not visible in the present drawing) being in that case a *psoas minor*. Not far from the anterior end of this *glutæus* there arises between its two heads (dorsal and ventral) a stoutish flat muscle (*m.p.*) of a coarse texture from the edge of the ilium. I was at first disposed to suspect that this muscle dipping down between the two, thus separating portions of the *glutæus*, might run parallel with them, but hidden from sight, to be inserted on to the femur. But a careful dissection showed that this was not the case. Some of the fibres of this muscle are attached to the lung in front, others passing round behind it; others again accompanying these, pass round behind the lung and traversing the ligamentum latum are inserted upon the œsophagus (woodcut fig. 2). The main mass of the muscle, however, traverses the floor of the chamber already spoken of as underlying the stomach, and is inserted on to the œsophagus and on to a fibrous aponeurosis lying behind the lung.

Fig. 2.

Lung, œsophagus, and related musculature in *Xenopus*.

L, lung; *Œs.*, œsophagus.

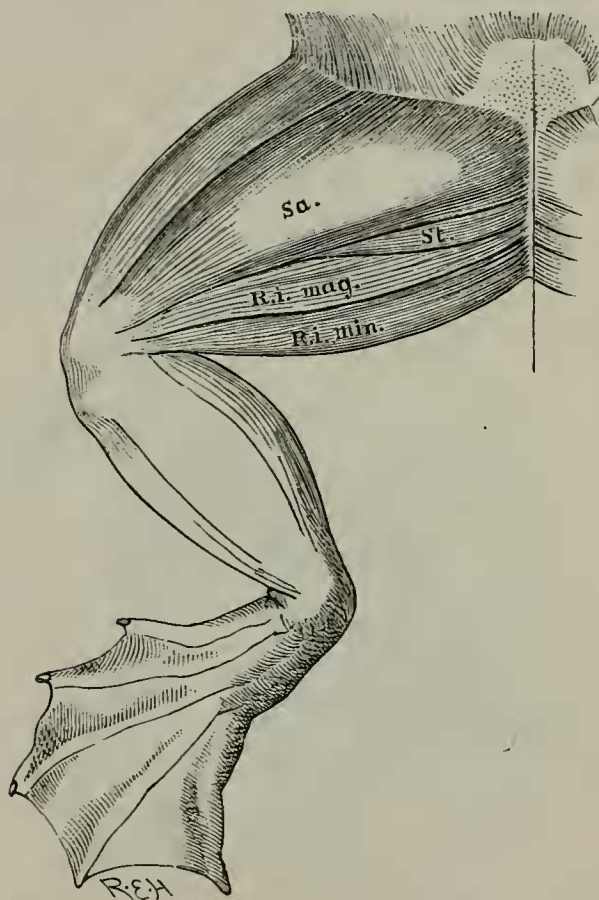
(2) The *obliquus internus*, as in *Rana* and in *Pipa* (see above, p. 831, fig. 2), enters into the formation of the diaphragm; a few muscular slips (fig. 1, *a*) are given off, which are attached to the base of the lung, traversing the mesentery already spoken of which connects the lung with the parietes. A large portion of the muscle,

¹ *Loc. cit.*

moreover, ends on the fibrous aponeurosis already spoken of as lying behind the lung.

(3) As in *Rana* and *Pipa*, the sterno-hyoid muscle bifurcates below the sternum into an anterior and posterior section. In *Xenopus* the posterior branch is a rather thin and narrow muscle which passes down at the level of the anterior end of the heart

Fig. 3.



Thigh-muscles of *Xenopus*.

Sa., sartorius; *St.*, semitendinosus; *R.i. mag.*, rectus internus major;
R.i. min., rectus internus minor.

at right angles to the sternum. The muscle is attached to the outer side of the wall of the sac which encloses the heart and pericardium, and is therefore posterior to all the great vessels which enter and leave the heart. Its fibres, which do not fan out to

any marked degree, nearly meet those of the upwardly running "*musculus pulmonum proprius*."

It is evident, therefore, that the "diaphragm" of *Xenopus* is in complexity markedly in advance of that of *Rana* and closely resembles that of *Pipa*.

§ *Myology*.

I have not attempted even so complete an account of the myology of *Xenopus* as I have of *Pipa*, incomplete though that was. I have contented myself with a description of some of the more important muscles which show variations in different types, and from which therefore it may be possible to draw conclusions as to affinities with the very few types of Anurous Amphibians whose myology is known. I have principally made use of Dr. Haslam's translation of Ecker's '*Anatomy of the Frog*'¹ as the basis of my comparisons; but I have dissected all the muscles referred to in a specimen of the large Solomon Island Frog, *Rana guppyi*.

The *Rectus abdominis* is a broad muscle which arises not only from the extremity of the pubis but also from the fascia of the thigh, as shown in the accompanying illustration (woodcut fig. 3); possibly, however, the muscle only arises from the cartilaginous plate at the end of the pubis (the prepubis), as I cannot distinguish any distinct line of demarcation between it and the adjacent *obliquus internus*. The fibres pass forward and diverge beneath the end of the sternum into the two recti, which are inserted underneath the sternum.

Obliquus internus. As has been just mentioned, this muscle appears to be quite continuous with the last; but as a portion of the entire muscle underlies the *obliquus externus* and gives off a branch to the lung, it must, I think, be regarded as *obliquus internus*. It will perhaps be in accord with convenience to regard that portion of the entire muscle which springs from the fascia covering the thigh as referable to the *obliquus internus*.

In my account of the myology of *Pipa americana*, I have referred to a remarkable muscle which I termed the "*pectoro-mandibular*," as descriptive of its origin and insertion. I find in *Xenopus* underlying the mylohyoid a mass of muscle which seems to correspond to this, though its insertions are different. It is, in fact, in *Xenopus* to be regarded as a portion of the deltoid, for its fibres run alongside of other fibres which arise from the clavicle and from the tip of the sternum, and are inserted upon the humerus with the rest of the deltoid; it forms, in fact, the clavicular head of the deltoid.

The *Depressor mandibulæ* arises, as in *Rana esculenta*, from the fascia covering the back, and is in actual contact with the anterior of the *latissimus dorsi*. The dorsal sheet of muscle formed by these two completely covers over the underlying *infraspinatus*.

The *Latissimus dorsi* consists not only of a portion corresponding to the same muscle in the Common Frog, but of a larger posterior

¹ Clarendon Press, 1889.

portion extending as far back as the margin of the thigh; this has been already described by Maurer¹ and its resemblances to a similar muscle in *Pipa* commented upon by myself². I need not therefore again refer to the matter.

The *Cucullaris* is a distinctly oblong muscle when seen before raising the supra-scapula. Its fibres, however, converge beneath the scapula into a long flat tendon, which is inserted into the scapular edge near to its posterior boundary, and where it is also widest. The left supra-scapula here deeply overlaps the right; the muscle, therefore, of the left side is dorsal to the right supra-scapula.

The *Rhomboideus* is a small delicate muscle arising by an oblique origin, which touches the middle line of the back anteriorly and diverges posteriorly; in its course it crosses the *cucullaris* on the outer side (*i. e.* that nearest the arm), and is inserted on to the supra-scapula anteriorly. The muscles are of course completely covered by the supra-scapula.

The *infra-spinatus* is entirely covered by the *latissimus dorsi*; and when this is removed its posterior half is seen to be concealed by the transversus. It is not a double muscle as in *Pipa*; but its line of origin is shaped like the figure 3, being indented in the middle; it does not anywhere reach the border of the supra-scapula. It is inserted in common with the *latissimus dorsi*.

The *Mylohyoid* appears to be entirely similar to the same muscle in the Common Frog.

The *Pectoralis* consists of the three usual divisions. The *portio sternalis anterior* is much larger than the *posterior*; the origin of these two divisions of the *pectoralis* is from the entire length of the sternum; they completely cover all underlying muscles. There is no *musculus cutaneus pectoris*.

Of the two muscles which are brought into view by cutting across and reflecting the sternal portion of the *pectoralis*, the *Sterno-radialis* is much the larger; it takes origin from, at least, two-thirds of the sternum, as well as from the epicoracoid; its fibres converge rapidly to form a narrow flat tendon.

The *Coraco-humeralis* is a large muscle; it arises along the whole of the coracoid and also from the end of the sternum.

The *Triceps femoris* consists of the usual three divisions. The *Rectus anticus* arises from a very narrow tendon, but rapidly swells out into a big muscle which ends in the fascia covering the *vastus internus*. In *Rana guppyi* the connection of this muscle is first with the *vastus externus*.

The *Semimembranosus* is a particularly stout muscle; but it presents no noteworthy particular. Neither does the *Biceps femoris*.

The *Adductor longus* is covered by the *sartorius*; it arises by a

¹ "Die ventrale Rumpfmuskulatur der anuren Amphibien," Morph. Jahrb., 1895.

² "On some Points in the Anatomy of *Pipa americana*," above, p. 827.

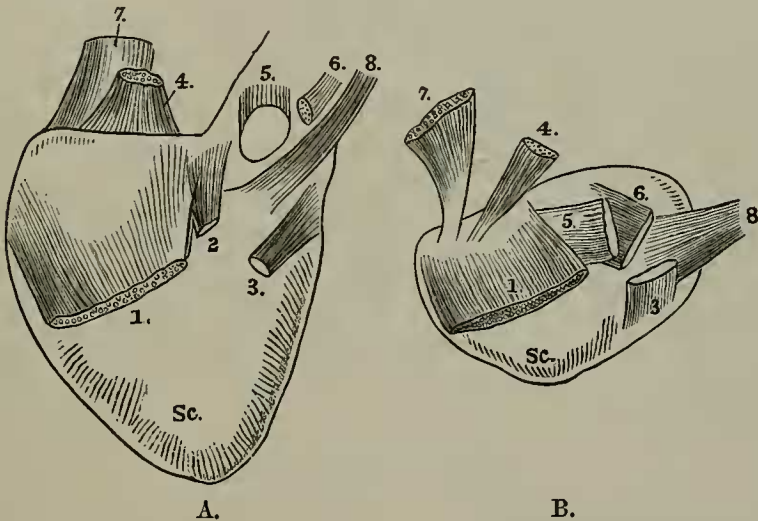
narrow stout tendon from the symphysis pubis, and at its insertion is wrapped round the insertion of the *adductor magnus*.

The latter (the *Adductor magnus*) arises behind the *Adductor longus*.

The *Adductor brevis* and *pectineus* form an inseparable fleshy mass.

The *Sartorius* (see fig. 4) is a very much larger muscle than it is in the Common Frog; it is over half an inch in diameter at its widest part. It arises not only from the symphysis of the innominate bones,

Fig. 4.



- A. Under surface of scapula of *Pipa*: 1, 2, 3, transversi scapulares; 4, 5, 6, protrahens scapulæ, levator anguli scapulæ, and sternocleidomastoid, attaching scapula to head; 7, cucullaris; 8, interscapularis.
- B. Under surface of scapula of *Xenopus*: 1-3, transversi scapulares; 4, rhomboideus; 7, cucullaris; 5 and 6 appear to correspond to those muscles so lettered in *Pipa* or perhaps to 4 and 5.

but from the cartilaginous pre-pubis, and from the septum between itself and the abdominal muscles; it thus appears to arise from the anterior margin of the thigh for about one-third of its extent. The posterior boundary is overlapped and covered for some depth by the *semitendinosus* and *recti interni*. The muscle may be said to have two insertions: one is muscular upon the knee-joint in contact with, but anterior to, the *rectus internus*; the other is upon the tendon and tendinous sheath which covers the end of the *semitendinosus*.

The *Semitendinosus* comes next to the *sartorius*; as already stated, it overlaps it and is itself overlapped, but not wholly concealed, by the *rectus internus*. It is a long thin flat muscle with a single muscular origin; there is no trace of a double origin as in the Frog, nor is there any connection with the *Adductor*

magnus, such as is figured by Ecker¹ in *Rana esculenta*. The muscle ends in a thin rounded tendon, whose relations with the *sartorius* have been already referred to.

Rectus internus, major et minor. In *Rana* and in *Pipa* there are two perfectly distinct *recti interni*; in *Xenopus* there are also two. The larger of the two, which I take to be the *major*, overlaps the *semitendinosus*, and is overlapped by the *minor*. The latter lies entirely superficial to the *major* and covers its posterior half.

On the outer side of the thigh the only muscles visible without a dissection are the *Semimembranosus* and the outer part of the *Triceps femoris*. The *Biceps* is largely concealed by the *vastus externus*; the great backward prolongation of the *Latissimus dorsi*—to which I have elsewhere² directed attention as a point of resemblance between *Xenopus* and *Pipa*—completely covers the *gluteus* and is attached to the thigh.

The *Gluteus*, after removal of the *latissimus dorsi*, is seen to be a very extensive muscle, much larger than in *Rana*. It is inserted by a flat tendon and also by muscle-fibre; between its insertion and the head of the femur is to be seen a portion of the *pyriformis*, which is nearly but not completely covered by it.

The *Psoas* is a fleshy muscle with a long insertion.

In order to effectively display the *pyriformis*, the *gluteus* must be removed or slit up the middle, and the two halves reflected. The *pyriformis* is then seen to be a large bipinnate muscle ending in a stout tendon, attached nearer to the head of the femur than *gluteus*.

§ Affinities of *Xenopus*.

The noteworthy peculiarities in the musculature of *Xenopus* as compared with *Rana* are:—

- (1) The large size and attachment of the *Sartorius*.
- (2) The single-headed *Semitendinosus*.
- (3) The enormous extension backwards of the *Latissimus dorsi*.
- (4) The absence of the *Pectoro-cutaneus*.
- (5) The attachment of the muscles covering the abdomen to the fascia covering the thigh.
- (6) The presence of a sheet of muscle below the *Mylohyoid* which joins the *Deltoid*.
- (7) The great extent of the *Pectoral*, which completely covers the *Sternoradialis*.
- (8) The large size of the *Gluteus*.
- (9) The existence of a special muscle running from the ilium to the lung and œsophagus.

There are also, as will be gathered from the foregoing account of the musculature of the animal, other differences from *Rana* of less importance.

Of the differences enumerated above, (3), (4), (5), (6), and (9)

¹ *Loc. cit.* p. 100, fig. 83, *st'''*.

² "On some Points in the Anatomy of *Pipa americana*," above, p. 834.

undoubtedly ally *Xenopus* more or less closely to *Pipa*. (1), (2), (7), and (8) are peculiar to *Xenopus*, and distinguish it from *Pipa* no less than from *Rana*.

Nevertheless I have been able to point out in this paper a few new points of likeness between *Xenopus* and *Pipa*, of which the most important is, in my opinion, the almost identical form of the "diaphragm" in the two genera, which has in both a musculature derived from three sources, instead of from only one as in *Rana*. The enormous *latissimus dorsi*, first described by Maurer, and the extension backwards of the abdominal musculature generally to overlap the thigh, is a strong approximation towards the actual attachment of these muscles to the femur itself in *Pipa*. These additional facts tend to justify the conclusion of Dr. Mivart¹ and of Mr. Boulenger², not to mention others, that the two genera should be closely united in any scheme of classification, and perhaps to render this union even closer than has been suggested.

On the other hand, there is the question of convergence raised by Cope to be dealt with. That naturalist suggested some thirty years ago³ that *Pipa* may be to the edentulous Anura what *Xenopus* is to the toothed forms—that they are, in fact, the summits of their respective series. Dr. Mivart has already discussed the value of the characteristics known at the time when he wrote as evidence of genetic affinity. I shall not attempt any recapitulation, but shall deal here only with the new facts detailed in the present paper. It must be always borne in mind that both *Pipa* and *Xenopus* are among the most purely aquatic of Anurous Amphibia; *Xenopus* is "essentially aquatic, the animal never leaving the water except in search of places where food or shelter are better supplied"⁴.

The attachment therefore of the abdominal musculature to the thigh is perhaps more useful to a creature which is as a rule in a horizontal position in the water and which rarely, if ever, adopts the typical frog-like attitude upon the land. This particular resemblance, therefore, between *Xenopus* and *Pipa* may perhaps be regarded as of less importance than some others.

We next come to the lungs and their musculature, for the other myological resemblances between *Xenopus* and *Pipa* are mainly, if not entirely, related to the facts referred to in the foregoing paragraph. One cannot help suspecting that the muscles attached to the lungs render possible a more rapid and thorough filling and emptying of the same with air—an advantage to aquatic though air-breathing animals. The great strength of the respiratory muscles in the whales⁵ is an analogy. The very differences between the lung-muscle of *Xenopus* and *Pipa* tend to support the

¹ "On the Classification of the Anurous Batrachia," P. Z. S. 1869.

² B. M. Catalogue of Batrachia Salientia.

³ Nat. Hist. Rev. 1865.

⁴ Leslie, "Notes on the Habits and Oviposition of *Xenopus laevis*," P. Z. S. 1890, p. 69.

⁵ Owen, Comp. Anat. vol. iii. p. 578.

view of their physiological identity, though perhaps morphological non-correspondence.

On the other hand, the last mentioned suggestion is not certain, especially in view of a statement of Mayer upon the lung-muscle of *Pipa*, which I have quoted in my paper upon that Amphibian. Mayer refers to the origin in *Pipa* of a lung-muscle from the ilium which I have not found myself, but which corresponds with what I have found in *Xenopus*. Apart, however, from the lungs, there is so great a resemblance between the entire musculature which goes to form what I have ventured to term the diaphragm, that I cannot look upon it as a case of convergence due to similar physiological needs. The only possible test for discriminating between morphological resemblance and a likeness due to similar needs would appear to be the complexity of the structures in question. Judged by this test, I am inclined to regard the new facts put forward in this paper as evidence of relationship between *Xenopus* and *Pipa*.

3. On the Colour-variations of a Beetle of the Family *Chrysomelidæ*, statistically examined. By W. BATESON, M.A., F.R.S., Fellow of St. John's College, Cambridge.

[Received December 3, 1895.]

(Plate XLVII.)

At a meeting of the Society on May 1, 1894, I exhibited living specimens of *Gonioctena variabilis* in illustration of the remarkable range of colour-variation in the species. Since then I have had opportunities for a fuller investigation of the matter, and the following paper is an account of the results obtained.

*G. variabilis*¹ is a small beetle, about $\frac{1}{4}$ in. long, belonging to the family Chrysomelidæ. It lives on *Spartium retama*, a plant allied to the Common Broom, very generally distributed in hilly places in the south of Spain, though absent, I believe, from the limestone districts. This plant grows as a bush varying in height from one to about seven feet according to the situation, humidity, and exposure. The stunted form is dense and compact, having stout branches spreading out more or less horizontally, giving off erect leaf-bearing stems set closely together. The tall form is slender and graceful, and its leaf-bearing stems are generally pendulous and wavy. In their extreme forms these two conditions of the plant differ considerably from each other, but all intermediate conditions are found.

In colour the stems of this *Spartium* are of a dull greenish grey. The surface is marked with irregular longitudinal ribbings, which give it an appearance of faint striping. It is upon the stems of this plant that the beetles live, infesting both forms indifferently. When at rest they are commonly seen sitting with their heads in the axils of the twigs, their bodies being closely pressed against

¹ The genus *Gonioctena* is *Phytodecta* of the Munich Catalogue. The species *G. variabilis* is the *Phytodecta ægrota* of Fabr. and Suffr.



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VARIATIONS OF GONIOCTENA VARIABILIS.



the surface. Several other species of *Spartium* grow in the south of Spain, but I did not find *G. variabilis* on any of them. Nevertheless, living specimens brought home to England ate the shoots of *S. juncifolium*, with which they were provided from the Cambridge Botanic Garden.

It was at Granada, on March 28, 1894, that I first saw *G. variabilis* and was at once struck by the great variety of appearance presented by different individuals. In a few minutes I came upon most of the chief kinds, including what will be described as the red form with black spots, the greenish-grey form with black stripes, a totally black form, &c. As may be seen from the figures (Plate XLVII.) these different varieties are strikingly unlike in general appearance, and not having previously heard of this beetle I at first doubted whether all were one species. Then, finding specimens of dissimilar colours coupled together, I concluded that they did all belong to the same species, and as all intermediate forms were afterwards found, there can be no doubt on this point. Subsequently Dr. D. Sharp, to whom I am indebted for much help in examining these specimens, gave me the name of the beetle and told me that it was known to undergo great variation in colour¹. I may add further that no difference could be seen in examination of the ædeagus of the several forms.

It appeared that the case was worth further investigation with the object of determining with what frequency the various colours occur, and to what extent specimens collected at random could be grouped round special type-varieties to the exclusion of intermediate forms, thus manifesting the phenomenon known as organic stability in respect of those varieties. As so many specimens were found *in cop.* it seemed further that by recording the colours of specimens so coupled it might be possible to get an indication whether there existed any operative sexual selection as to colour.

The next few days were spent in gathering a sufficient sample, and I then returned to Gibraltar to follow other work. Very soon, however, I found that the colours had so faded that the collection already made was useless for my purpose. In fact, in dried specimens the red and the green both usually fade to an indifferent brown. I therefore went back to Granada and gathered a fresh sample of about 1500. These I put into a large wooden box and brought alive to England. In the following year (1895) I returned to Granada and collected, on March 24–28, about 2500 more, recording all the colours at the time.

It at once appeared that the colour is to a great extent dependent upon sex, the males being generally of the red form with spots like fig. 1, while the females are generally of the greenish form with stripes like fig. 23, though every colour is sometimes found in each sex. For this reason, before sorting the specimens for the purpose of determining the frequency of each

¹ Several varieties have been briefly described by Weise (Deut. ent. Zeitschr. 1891, p. 160), but I infer that the colours were given from dried specimens.

colour, it is necessary first to sort them in respect of sex. This can be done without much difficulty. Besides a slight difference in shape and in sculpture (which gives to the elytra of the female a duller lustre) there is a well-marked depression or pit in the last uncovered abdominal plate of the male, while in the female there is no such depression.

In attempting to arrange or group the specimens according to colour confusion is caused by the fact that variation occurs in several distinct features. Of these the three most noticeable are :

- (1) The ground-colour of the elytra.
- (2) The distribution of black pigment on the elytra.
- (3) The colour of the legs and underside of the body.

Since the variations of the first two points are largely independent, it is not possible to exhibit the relationships and frequencies of all the variations by arranging the specimens in *one* series. The whole number, males and females, can, however, be seen to consist of two chief kinds—the one distinguished by having four *black spots* on the elytra (figs. 1-6, &c.) and a dark, generally black, underside to the body, while the other has an appearance of *black striping* on the elytra (figs. 20-23) associated with a light testaceous underside to the body. Those with undersides that cannot at once be referred to either the dark or to the light division are rare; in the Tables given they are included under the heading “unconformable.” In those with light undersides the legs are of a similar testaceous colour. If the underside is black, the femora are generally black too; but frequently the coxæ and tarsi, and less often the tibiæ, are of a lighter colour.

Examined closely the distinction between the distribution of the spots and the stripes is seen to be as follows:—The striping consists of pigment deposited in certain positions that can be defined pretty accurately by reference to the punctulations. These are somewhat more regularly disposed in the female than in the male, but by standing back to the light and looking at the specimen from behind it can be seen that the following arrangement is fairly constant. Following a line across the middle of an elytron there is next to the suture a double row of punctulations. External to this is an interval. Then come the 2nd-8th double rows of punctulations separated by intervals. Outside the eighth interval is a 9th row of punctulations, which is irregularly treble.

It is in the four intervals between the 2nd and 3rd, 4th and 5th, 6th and 7th, 8th and 9th double rows that the four chief tracheæ of the elytron run; but the four principal stripes of pigment are placed in the *other* intervals, viz., between the 1st and 2nd, 3rd and 4th, 5th and 6th, 7th and 8th double rows of punctulations. There are not rarely a few dots of pigment in the other intervals, and, in the case of heavily striped specimens, these sometimes unite to form secondary stripes.

The definite “spots,” however, that are associated with the

black undersides (as in fig. 1, &c.) consist of patches of pigment usually placed so as to *cross* respectively the one the 2nd, 3rd, and 4th, the other the 7th and 8th double rows of punctulations. The extent of these spots varies greatly and in its condition of least development the central of the two spots coincides very nearly with the 3rd double row of punctulations, and the lateral spot similarly is very nearly on the 7th double row.

All these arrangements are liable to irregularity, but in the main they are as described, and essentially in the spotted form pigment *crosses* certain of the double rows of punctulations, while in the striped form it is almost entirely in the *intervals* between them.

The association of the black spots on the elytra with a dark underside is exceedingly close, and it scarcely ever happens that a specimen which has black pigment in the position of the spots (fig. 1) has a light underside. This principle is obeyed whatever the ground-colour of the elytra may be. Figs. 25 and 26, 28-30 are given as illustrations of specimens in which the rule is not followed, the undersides not being black though there is black pigment on the elytra in the situation of the spots.

This division into spotted forms with dark undersides and striped forms with light undersides is the most conspicuous feature in the variation of the insect. In great measure the distinction is sexual, most of the males belonging to the spotted division and most of the females to the striped. Curiously the number of each sex which belongs to the opposite group is about the same, for on sorting it appears that

Of <i>males</i>	about 80 per cent.	are of the spotted class.
"	18	" " striped "
Of <i>females</i>	25	" " spotted "
"	71	" " striped "

This reckoning is made without reference to ground-colour, and specimens that have striping as well as spots are of course included in the spotted class, to which they belong also by reason of their dark undersides.

Of the spotted form the great majority (73 per cent. of all males and 19·6 per cent. of all females) have red as the ground-colour of the elytra. Of the striped form, on the other hand, the majority (19 per cent. of all males and 65·7 per cent. of all females) have greenish grey as the ground-colour. In fact the great majority of males agree pretty closely with fig. 1, while the great majority of females resemble fig. 13; but of the males the *next commonest* form is that shown in fig. 13, and of females the second commonest is that of fig. 1. It thus appears that the form which may be called normal for the female is the commonest variety in the male, and the converse is true though to a less degree.

The thorax of the striped forms usually has black pigment as

two black spots (see figs. 19-24), while in the spotted forms the thorax is generally black with some lighter colour at the periphery and not rarely in the middle line.

Considering the *ground-colour* of the elytra there are thus two chief kinds, red and greenish grey. The majority can at once be referred to one or other of these two. Nevertheless there are intermediate colours forming an unbroken series or transition from the one to the other. Such a series is represented in figs. 1-6. Starting from the bright red kind (fig. 1) and passing through a duller red (fig. 2) a neutral buff (fig. 3) is reached. This buff is almost exactly intermediate between the red group and the greenish grey. The next stages in the transition are yellow (fig. 4), yellowish green, and greenish grey (fig. 6).

Taking *spotted* males alone the bright reds are by far the commonest, the duller reds are the next commonest, the buff are very rare, while yellows and greenish together make up a fair group. As to the relative frequency of these yellows and greens, the data are unreliable. The total number belonging to these classes was small, and it is not possible to sort them among themselves with any strictness. I am satisfied that the yellows are more common than the buffs, and the *spotted* greenish greys are probably less common than the yellows; but of this I am not sure. In the Table given at the end I have united them.

Of *striped* males almost all are greenish grey. Reds and yellows occur, but are exceedingly rare. The whole number of striped specimens with a ground-colour other than greenish grey is so small that it is not possible to judge the frequency of the respective colours. I attempted for some time to distinguish different shades of the greens according to the degree of yellow. But while certain of the striped kinds are obviously yellow and others are obviously yellowish green, it was not found possible to sort consistently the yellowish greens from the greens with less yellow, so this attempt was abandoned.

With a view to determining the nature of the colouring-matters, an examination of some specimens was very kindly made by Dr. H. C. Sorby. The material sent to him consisted of a few of the reds and a few of the greenish form separately killed and preserved in alcohol. Dr. Sorby informs me that the red pigment is slowly dissolved out by alcohol and carbon bisulphide, and when in solution in the latter is of exactly the same character as the similar pigment of the common Lady-bird (*C. bipunctata*). After long action to dissolve out all the pigment of the elytra, the red form is left of a yellow colour, exactly like that which is assumed also by the greenish kind. Dr. Sorby therefore conjectures that the reds differ from the others mainly on account of the development of the red pigment which is not found in the others. It is therefore possible that the ground-colours intermediate between the red and the greenish may be due in some measure to a difference in the amount of red pigment; but it seems likely that in the

case of the yellow, which is a distinct colour, there must be an alteration in the nature of the pigment.

Specimens are occasionally found having the elytron of one side red and that of the other side yellow (fig. 31). Not very rarely also there are more or less distinct patches of yellowish colour on the red ground, as in fig. 32, where they happen to be nearly symmetrical. These specimens are included in the Tables under the head of "unconformable."

In addition to the varieties already mentioned, there is also a series of melanic forms. We have seen that the black pigment of the elytra may either take the form of stripes or of spots. From the latter group (fig. 1) a noticeable series of variations leads to a form totally black above and below. Such a series is illustrated by the figures 7-12 and 15-18. The first step in the progressive pigmentation consists in the appearance of black in the positions of the stripes, which is gradually extended. These specimens are thus both spotted and striped. The parts last invaded are the apices, the shoulders, and the borders of the elytra¹. The spread of the black is perhaps never quite symmetrical on the two sides and is not rarely noticeably asymmetrical to the degree shown in the figures.

The series of progressive pigmentation is closely parallel to that seen in *Coccinella bipunctata*, the common Lady-bird.

Though the invasion of the black pigment proceeds along tolerably regular lines, darkening the parts of the elytra in a fairly constant order, yet as regards quantity of pigment variation towards the black form proceeds continuously, the states becoming successively rarer as the full black is approached. From the fact that the progress is so even it is not easy to give numerical expression to this; but on sorting the specimens which have more black than fig. 1, it is found that while there are many which approximate to figs. 7 and 8, there are fewer which resemble figs. 9 and 10; those with only a few specks of red, like fig. 11, are still rarer, while the totally black state is rarer than any of the others.

The darkening of the head and thorax proceeds more or less evenly with those of the elytra, but the correlation is not strict.

These melanic forms are, as has been said, an offshoot of the spotted kind and not of the striped. They have red as the ground-colour almost without exception. Fig. 26 represents the darkest specimen I have seen with greenish ground-colour.

A few specimens are found without any black markings on the elytra at all. These have the undersides testaceous. In such specimens the thorax has generally very little pigment and is occasionally entirely without any.

¹ Curiously enough, the two specimens figured by Olivier, *Hist. Nat. des Insectes*, pl. viii. fig. 127, *c* and *d*, are both of these very melanic forms. The locality is not given, and perhaps the frequency of the varieties may differ with locality.

There is some suggestion that the frequency of the different variations may be in part dependent on locality. The great mass of my specimens were collected on the hills that extend behind the town of Granada, separating the two valleys of the Genil and the Darro. In the first year I made a separate collection also from the *Spartium* growing near the bottom of the Darro valley. I noticed at once that the proportion of the striped forms with greyish-green ground-colour was much larger than it had been in the case of the hill-locality. Unfortunately I was not at that time expert in sorting the sexes, and this Darro sample was eventually mixed with the rest that I brought, living, to England. The colours were recorded, but without reference to sex.

The second year, however, I made another attempt to get statistics of the Darro population, and give the result in Table II. The total numbers are unfortunately small, as the available area on which the *Spartium* grows is not extensive; but the quantity is sufficient to show that the proportions are markedly different from those of the hill-sides, for while on the hill-sides 19 per cent. of males are of the striped greenish grey, in the Darro valley about 37.7 per cent. are of that colour. I am disposed to think this difference in proportion is a perfectly genuine phenomenon and not merely an accident of collection, but I can suggest no cause for it. The difference in altitude is very slight, averaging, perhaps, 300 feet. No doubt the Darro bushes are rather larger and better watered, but many of the bushes on the hills are of the same character and I did not find a high proportion of greens on them. The Darro valley is no doubt less exposed and rather hotter than the hill-sides, but it would not be easy to point to a specific difference.

A peasant employed as a "Guardia Municipal," with whom I made acquaintance, collected for me a considerable sample of some hundreds from Pinos, higher up the Genil valley. The proportions agreed fairly with my Granada sample; but as I knew nothing of the way in which they had been collected, the numbers are not worth giving.

On the 20th of March, 1895, during an interval between trains at Castillejo¹, a place not far from Toledo, in a hasty sweeping I got 75 specimens, only one being a female. Of these none are of the striped greenish-grey form. The number is of course too small to justify a conclusion; but the result is remarkable, for according to the Granada experience there should have been about 14 such specimens. It is possible that in this more northern locality the proportions may be different. The scarcity of females is also to be noted and may perhaps be due to comparative backwardness of the season.

It seems that at Granada at all events the beetles are to be found for a considerable part of the year, for Mr. Nicholson has kindly sent me a small gathering made in the month of June.

¹ As travellers from Toledo for the south generally have to wait some hours at Castillejo, it is not unlikely that some entomologist may find an opportunity of looking into this matter. The *Spartium* grows in quantity near the station.

In the Table the frequency with which specimens of each colour were taken *in cop.* is recorded. In each case special care was taken to see that the pair were actually coupled, and none were counted for this purpose unless they remained attached when removed from the bush. It will be seen that the numbers agree very fairly well with those that they should be if the coupling occurred by simple chance, for the number of each colour found coupled bears about the same proportion to the whole number found coupled that would be expected according to the frequency of that colour.

It is clear that we have here an example of a species whose members exhibit variation in several different respects, and that the variations occur in such a way that the individuals must be conceived as grouped round several subtypical forms. There is thus not one normal for the species but several. Next, though all are living in the same locality under the same conditions, and though they breed freely together, these various forms are commoner than the intermediates between them¹. Upon the significance of such a case I have sufficiently commented elsewhere².

One point may be of interest to students of the adaptation of the colours of animals to their surroundings, namely the fact that while the red-spotted forms are strikingly conspicuous objects the striped greenish-grey forms resemble so nearly the colour of the twigs of the *Spartium* that it is impossible not to remark the likeness. If they were the only form known, the case might well be used as an illustration of a protective coloration. The red-spotted forms present some superficial likeness to the common Lady-bird (*C. bipunctata*), a creature which exudes an acrid juice, and whose colour has naturally been classed among "warning colours." The *Gonioctena* does not, so far as I know, possess any such irritant properties, but I have no information as to its enemies. As *Coccinella bipunctata* is not very common on the *Spartium*, probably no one will suggest that we have here an example of protective mimicry. I may mention, however, that *Coccinella septempunctata*, the larger scarlet species, occurs in vast quantities mixed with *Gonioctena*. Whether anyone would consider the resemblance to this species sufficiently close to constitute mimicry, I cannot say.

Speaking of the excessive variability of the colour of *C. decempunctata* and of the no less striking constancy of *C. septempunctata*, which lives with it, I remarked³ that to ask us to believe that the colour of the one is constant because it matters to the animal, and that the other is variable because it does not matter, is to ask us to abrogate reason. Mr. A. R. Wallace, in a recent article⁴, takes exception to this comment, saying that he, for his part, is of this

¹ As was pointed out, this is not true of the *black* variety.

² 'Materials for the Study of Variation,' 1894, pp. 48, 72, &c.

³ *L. c.* p. 572.

⁴ 'Fortnightly Review,' March 1895, p. 436.

TABLE I.—*Granada, 1894 and 1895.*
Collected on the hills between Darro and Genil.

MALES.	Swept.	Taken in cop.	Totals.	Percentage.
<i>Undersides dark.</i>				
Spotted: ground-colour bright red	1657	} 139	2186	} 73·7
" " duller red	390			
Spotted and striped, tend- } ground-colour red.	177	9	186	
ing towards black				
Spotted: ground-colour reddish buff	39	...	39	
" " neutral buff	25	...	25	
" " yellow to greenish grey.	100	12	112	
Black all over	7	1	8	
Striped only: ground-colour greenish grey.....	3	...	3	
No stripes or spots: ground-colour red	1	...	1	
Unconformable	35	3	38	
			2598	81
<i>Undersides light.</i>				
Striped: ground-colour greenish grey	596	24	620	19
" " red	5	...	5	
" " yellow.....	1	...	1	
Spotted and striped: ground-colour greenish grey	2	...	2	
No stripes or spots: ground-colour plain red ...	2	...	2	
Unconformable	2	...	2	
			632	19
Total captured		188	3230	
FEMALES.				
<i>Undersides dark.</i>				
Spotted: ground-colour red	102	27	129	} 19·6
Spotted and striped, tend- } ground-colour red.	42	9	51	
ing towards black:				
Spotted: ground-colour buff	5	...	5	
" " yellow to greenish grey	34	13	47	
Black all over	9	3	12	
Unconformable.....	5	3	8	
			252	27·5
<i>Undersides light.</i>				
Striped: ground-colour greenish grey	497	116	613	65·7
" " yellow	26	14	40	
No black: " plain red	1	1	2	
Unconformable.....	8	2	10	
			665	72·5
Total captured		188	917	

TABLE II.—*Darro Valley*, 1895.

MALES.		Swept.	Percentage.
<i>Undersides dark.</i>			
Spotted : ground-colour red.....		341	} 58·3
" " duller red		41	
Spotted and striped, tend- ing towards black : }	ground-colour duller red ...	37	
Spotted : ground-colour buff		5	
" " yellow to greenish grey		17	
Black all over.....		3	} 62·3
Unconformable		3	
		447	
<i>Undersides light.</i>			
Striped : ground-colour greenish grey		270	} 37·7
No black : " red		1	
		271	
Total captured		718	
FEMALES.			
<i>Undersides dark.</i>			
Spotted : ground-colour red.....		9	
Spotted and striped : ground-colour red		7	
Spotted : ground-colour buff		5	
" " yellow to greenish grey		6	
Black all over.....		1	
		28	14·4
<i>Undersides light.</i>			
Striped : ground-colour greenish grey		164	} 85·6
" " yellow		3	
		167	
Total captured		195	

very opinion. On the question *how* it is that the colour of *C. septempunctata* is so important, and the colour of *C. decempunctata* unimportant to the animal, I do not find Mr. Wallace offering evidence, and I am not aware that he has even hazarded a guess. Meanwhile I wish to repeat, in regard to *G. variabilis* what I said before in the case of *C. decempunctata*, that its several varieties exhibit that kind of definiteness and constancy to their respective types that we associate with the idea of species; but for supposing that this constancy is in any way dependent on adaptation to environment, we have no warrant.

EXPLANATION OF PLATE XLVII.

These figures have been drawn by Mr. Edwin Wilson from the living specimens. The colours were very carefully copied, but it was not thought necessary to reproduce the sizes and shapes of the individuals. The figures are about twice the natural size.

With the exception of figs. 18, 22, and 27, which represent females, all were taken from males.

Figs. 1-6. Series illustrating the change of ground-colour from red to greenish grey.

Figs. 1, 7-12 are a series illustrating the progressive invasion of black pigment. Figs. 13-18. Various forms illustrating diminution and increase in amount of black pigment.

Figs. 19-24. Forms with light undersides.

Figs. 25-30. Unconformable cases.

Figs. 25, 26, 28, 29, and 30 show specimens having light undersides, though they have transverse black markings in the position of the spots.

Figs. 27 and 28 are peculiar in the fact that, though melanic forms, the ground-colour is yellowish buff instead of red.

Fig. 30. Underside of intermediate colour, associated with a slight indication of transverse black marking.

Fig. 31. Specimen having right elytron red and the left yellow.

Fig. 32. Specimen having patches of yellow on red elytra.

The undersides were black in the case of figs. 1-18, 27, 31, and 32; light in the case of figs. 19-26; of intermediate colour in the case of figs. 28-30.

A leg is drawn in some cases, and the small square beside it represents the colour of the underside without shading. The elytra are all coloured as if they had no high light on them, in order to give the colour more correctly, but actually they reflect a bright light.

4. On the Affinities of the so-called Extinct Giant Dormouse of Malta. By R. LYDEKKER.

[Received October 2, 1895.]

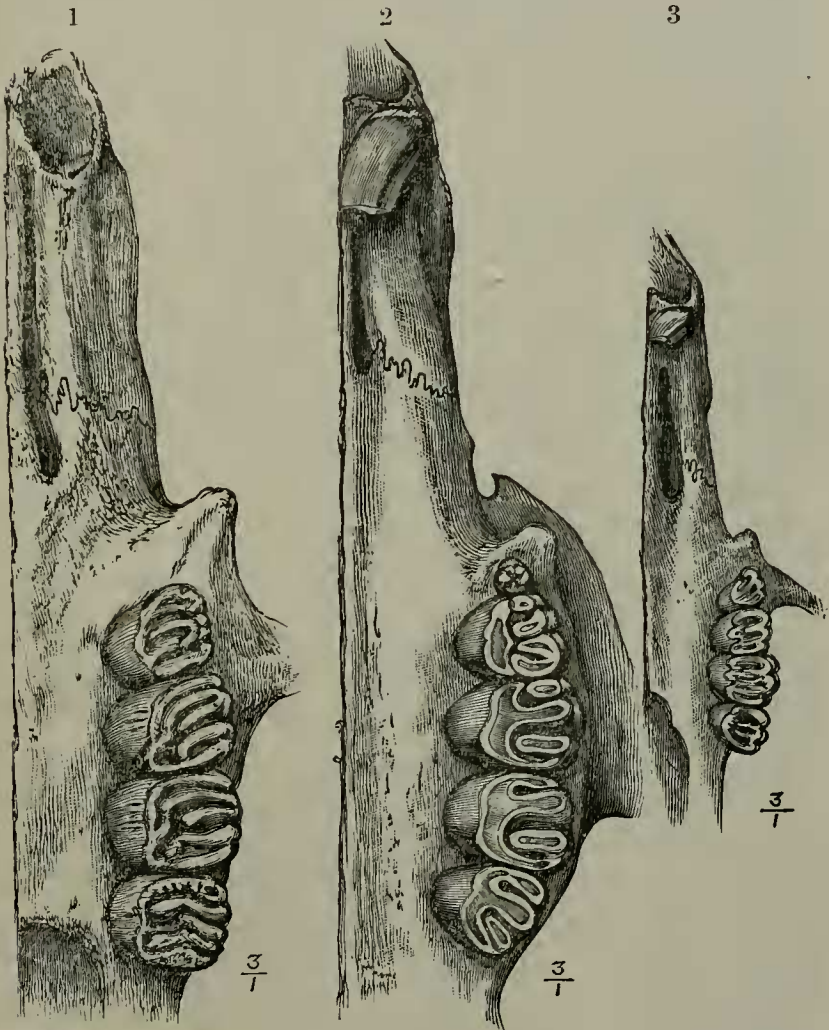
It has always been a matter of some surprise that while the other extinct Dormice agree with the living members of the family in their comparatively small size, the rodent from the Pleistocene of Malta assigned to the genus *Myoxus* is a much larger animal, agreeing approximately in dimensions with the Oriental *Sciurus bicolor*. Recently Mr. Andrews, of the British Museum, told me that he believed this so-called Dormouse was not a member of the *Myoxidae* at all; and this induced me to undertake a re-examination of the specimens in the Museum, with the result that I am quite convinced of the correctness of his opinion.

Myoxus melitensis was first described by Leith Adams in the Journ. R. Dublin Soc. vol. iv. p. 18 (1863), and more fully in the Trans. Zool. Soc. vol. vi. pp. 307 *et seq.*; while some of its remains were also figured in plate iii. of his 'Notes on the Nile Valley and Malta' (1870). The name *Myoxus cartei* also occurs in the same memoirs, although this appears to be a synonym of the former. Among the remains figured from Malta there is, however, a lower jaw¹ assigned to the young of *M. melitensis*, which appears

¹ 'Nile Valley and Malta,' pl. iii. fig. 7.

to belong to a true Dormouse and, from the presence of a perforation near the angle, may be assigned to the genus, or subgenus, *Eliomys*.

Unfortunately, none of the skulls or lower jaws in the British Museum are complete, although some of the latter are sufficiently well preserved to show that the angle is constructed on the plan obtaining in the *Sciuromorpha* and *Myomorpha*. One example of



Left upper cheek-teeth of (1) *Leithia*, (2) *Xerus*, and (3) *Myoxus quercinus*.

the cranium shows a very important difference from the *Myoxidae* in the region of the snout. In all the members of that family the infraorbital foramina are large and open in the maxilla at the fore root of the zygoma, in a manner somewhat similar to that obtaining in the *Muridae*. On the other hand, in the *Sciuridae* the same foramina are of very minute proportions, each forming merely a small slit at the junction of the premaxilla with the

maxilla, situate considerably in advance of the anterior zygomatic root. Now in this respect the fossil apparently differs from the Dormice and resembles the Squirrels¹.

As regards the cheek-teeth, these present a considerable superficial resemblance to those of such Dormice as have complicated enamel-folds on the crown. Closer examination shows, however, a marked difference, well displayed in the accompanying figures (p. 861). In the simpler type of upper molars in the Dormice (*Eliomys*) the folds form ridges, of which two unite to form columns on the outer side of the crown, so as to give a somewhat tritubercular form to the whole tooth; and where the ridges are more complex (*Myoxus*), and form more distinct plates, these curve together in pairs on the outer side of the crown. On the other hand, in the Maltese animal the four or five blunt ridges diverge from the inner or postero-internal portion of the crown in a comb-like manner, without any tendency to approximate on the outer border, one or two of these ridges being shorter than the rest and arising by a splitting of the enamel-folds. Both *Eliomys* and *Myoxus* have distinct outer columns to the upper molars, while *Muscardinus* differs markedly from the fossil in that the upper premolar is very small and the first molar much longer than the second. The foldings, too, on the second molar are much finer and of a different type.

Comparing this type of dentition with that of the *Sciuridæ*, the nearest approximation is presented by *Xerus* and *Pteromys*. In the former two main ridges and two talons proceed outwards from an inner wall; and in the latter this inner wall becomes thinner, and the two talons are so developed as to be counted as ridges. Although these ridges and the three intervening enamel-folds, or valleys, are much deeper than in the Malta form, yet it seems not impossible that both types of teeth might be derived from a common stock.

Seeing, therefore, that the Maltese rodent does not belong to the *Myoxidæ*, while it presents certain resemblances to the *Sciuridæ*, I think it may be provisionally assigned to the Sciuromorpha, although it is quite probable it may constitute a family (*Leithiidæ*) by itself. As it requires a new generic title, the name *Leithia*, after its describer, may be suggested; and the genus may be provisionally defined as specialized Sciuromorpha with squared upper molars bearing from four to five simple, low, parallel transverse ridges, three of which rise from the postero-internal angle or inner side of the crown, while the remainder are shorter and are formed by a single or double splitting of the more anterior of the two hind-

¹ As pointed out to me by Mr. de Winton, the palatine foramina differ from those of existing Sciuromorpha in extending backwards well into the maxillæ, as in the Myomorpha, instead of being confined to the premaxillæ. In *Arctomys*, however, these foramina intrude somewhat into the maxillæ, so that the feature does not seem of much value. Neither am I inclined to attribute very much importance to the distal union of the tibia and fibula which takes place in the fossil form, although such union is unknown in the living Sciuromorpha, while it is universal in the Myomorpha.

most enamel-folds. There is no trace of the presence of more than one pair of upper premolars. The palatine foramina are elongated, and the tibia and fibula united. Whether the skull had the well-developed postorbital processes characterizing existing Squirrels, I am unable to determine; but it was evidently constricted in the orbital region, like *Sciurus*, and thus unlike that of *Xerus*. The restoration of the lower jaw given by Leith Adams is probably incorrect. It is certain that *Leithia* does not belong to the Myomorpha, and I do not think the features in which it differs from other Sciuiomorpha are sufficient to justify its reference to a suborder by itself.

5. On Loder's Gazelle in Egypt, and the Mode of its Capture by the Arabs. By W. E. JENNINGS BRAMLEY.¹

[Received October 23, 1895.]

On the 27th of June I started from the Pyramids in order, if possible, to catch some living specimens of Loder's Gazelle (*Gazella loderi*)², known to the Arabs as *Rasal Abiad* (the White Gazelle), which the shikaries whom I took with me reported to be found in the desert at some thirty or forty miles distant from Cairo.

Leaving at 4 P.M. on the 27th, we started, taking a south-easterly direction. We travelled till 12 that night, and at 4 next morning resumed our march. Soon after the sun had risen, one of the shikaries, pointing to the ground, showed what he made out to be the spoor, evidently but lately made, of a fine male Loder's Gazelle. This, being larger than that of the Dorcas Gazelle, is very easily recognizable; the bluntness of the hoof in the case of Loder's Gazelle shows a marked difference. About 12 o'clock one of the camel-men called out that a Gazelle could be seen ahead, but the many heaps of white stones, scattered all over the desert, are so deceiving at a little distance that both shikaries shook their heads.

The habit that all Gazelles have, when first viewing an approaching danger, of standing motionless for some time, is carried to such an excess in this particular species that it is often possible to get within easy rifle-range by quietly walking up, without taking any particular care to hide the approach. On the other hand, the animal is often missed entirely, and passed by at some little distance as a heap of bones or of white stones.

The camel-man, however, in this case proved to be correct, as we soon noticed the Gazelle walking leisurely away. It disappeared behind a mound of sand, where it must have remained, for, on reaching the place about half an hour later, we were surprised to come suddenly on the Gazelle, now only some 200 yards off. It

¹ [Mr. Bramley has kindly drawn up these notes at my request. It will be recollected that the existence of Loder's Gazelle in Egypt has only lately been established upon a specimen procured by Mr. Bramley. *Vide supra*, pp. 400, 522.—P. L. S.]

² Thomas, P. Z. S. 1894, p. 470, pl. xxxii.; *Sci. supra*, pp. 400, 522.

was a fine female, very white in colour. Not wishing to disturb any others that might be near, I did not fire. We found, however, that it was alone. At 12 o'clock or thereabouts we came upon the skirt of the plateau, from which the Fayoum can be seen, and here the shikaries decided to turn back, as they said we had passed the "White Gazelle ground;" so, after returning about two miles, we set up the tents and waited for the evening, the sun being so hot that it was impossible to continue our search. Two Arabian greyhounds I had with me felt the heat especially. No sooner were the camels on the ground than, going to the shady side, they began to dig in the sand under the beasts in order to bury themselves away from the heat.

During the afternoon the two shikaries constructed traps, which we set in the evening.

The Gazelle trap, except the small hemp-platted rope, is made entirely from the date-palm. Taking the long leaves, the shikarie first constructs by platting them together a deep ring, about 3 inches in diameter and about 4 inches deep: it should, in fact, fit well into a golf-hole and make its walls secure. He now takes an old stalk from which the dates have been picked, and separating about twenty of the fibres which compose it, and run its whole length, he twists them into a rude bracelet about three inches in diameter. Then taking three more fibres, in place of twine, he binds the ring securely; the ring or bracelet has then a form much resembling a diminutive "Ringold" ring. The shikarie now breaks off the points of the date-thorns until he has about twenty-five of them 2 inches in length; these he pushes through the fibrous sides of the ring until all the points meet in the centre, so that when finished this ring has much the appearance of a small sieve. All the thorn-points overlap slightly in the centre of the ring. This ring, holding all the thorns, the deep ring of platted leaves, and a soft thick hemp rope, made by the Arab himself, by the ordinary three-plat from raw hemp (this rope, being soft, not only binds itself more securely to the Gazelle, but does not cut the skin when drawn tight), attached to a date-stick about a yard in length, are all the implements that an Arab requires to catch a Gazelle.

Starting in the evening for the lower ground, which is studded with small bushes (for when pitching the tents we purposely kept at a good distance from the feeding-ground), we soon found spoor, but none very promising; a buck and two does had been there two nights before. A small desert plant, much resembling our English Red Cranesbill (*Geranium sanguineum*), was pointed out to me by the Arabs as a favourite food of the Gazelles. Finding a spot where the spoor led to one of these plants, and the plant evidently having been nibbled at, we decided to put a trap near it. The Arab sat down and made a hole, using his deep ring to keep its sandy walls intact, so that he now had a hole resembling exactly in size and depth a golf-hole with basket-work sides, within four or five inches of the plant.

Taking now the thorny ring he places it on the hole, which it should exactly cap. He now powders up some camel-dung and

